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Seismic interferometry by multidimensional deconvolution applied to ambient noise recorded in Malargüe, Argentina

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Seismic interferometry refers to the principle of generating new responses. These new responses are conventionally obtained by simple crosscorrelation of recordings made by separate receivers: a first receiver acts as 'virtual source' whose response is retrieved at the other receivers. The recorded wavefields may be passive (e.g. seismic noise) or active (e.g. in an industrial context). The newly retrieved responses can be used to extract receiver-receiver phase velocities, which often serve as input parameter for tomographic inverse problems. More recently, the coda of the newly retrieved responses have been found to correlate with temporally varying parameters such as hydrocarbon production and precipitation. For all applications, however, the accuracy of the retrieved responses is of great importance. Irregularities in the illumination patttern often degrade this accuracy: correct response retrieval relies on a uniform illumination of the receivers. Reformulating the theory underlying seismic interferometry by crosscorrelation as a multidimensional deconvolution (MDD) process, allows the removal of the imprint of the illumination pattern on the retrieved responses by means of a so-called point-spread function (PSF).

We use a seismic array in Malargüe, Argentina, to assess the feasibility of SI by MDD on ambient seismic noise recordings. The array, which has an aperture of approximately 60 km, is located just east of the Andean mountain range. The shape of the array lends itself well for the application of SI by MDD: its T-shape allows the construction of a PSF along one of the two receiver lines. These receivers act as the virtual sources and their responses are retrieved by the receivers along the other (perpendicular) line of receivers. A frequency-dependent analysis of the slowness along both lines allows us to select time windows during which most ambient seismic surface waves propagate in a favorable direction, that is, traversing the line of virtual sources prior to arrival at the receivers at which we aim to reconstruct the responses. During these time windows the wavefield therefore fulfills the assumption underlying SI by MDD that there is only energy propagating from the virtual sources to the receivers. Both the PSF and conventional crosscorrelations between the virtual sources and the receivers are computed from the selected time windows. We find that multidimensionally deconvolving the virtual-source responses by the point-spread function improves the responses' accuracy.